November 20, 1851.

COLONEL SABINE, R.A., V.P. & Treas., in the Chair.

George T. Doo, Esq. and Dr. Hofmann were admitted into the Society.

No paper was read; the time of the Meeting being occupied by reading the Minutes of the last Meeting, and the titles of the numerous presents received during the recess.

November 27, 1851.

COLONEL SABINE, R.A., V.P. & Treas., in the Chair.

A paper was in part read, entitled "Experimental Researches in Electricity. Twenty-eighth Series. On Lines of Magnetic Force; their definite character; and their distribution within a Magnet and through Space." By Michael Faraday, Esq., D.C.L., F.R.S., &c.

December 1, 1851.

At the Anniversary Meeting,

The EARL OF ROSSE, President, in the Chair.

Dr. Wallich, on the part of the Auditors of the Treasurer's Accounts, reported that the total receipts, during the past year, including a balance of £156 18*s.* 8*d.*, amounted to £3938 9*s.* 6*d.*; and that the total expenditure, during the same period, amounted to £3791 1*s.* 0*d.*, leaving a balance in the hands of the Treasurer of £147 8*s.* 6*d.*

The thanks of the Society were voted to the Treasurer and Auditors.

The President announced that Sir Philip Egerton, Bart., had been nominated by the Council a Trustee of the Soane Museum.

List of Fellows of the Royal Society deceased since the last Anniversary (1851).

On the Home List.

His Majesty, Ernest Augustus, The King of Hanover.

John James Audubon, Esq.
John Baron, M.D.
Henry Beaufoy, Esq.
The Right Hon. Lord Bexley.
James Ebenezer Bicheno, Esq.
Michael Bland, Esq.
John Burns, M.D.
Maj.-Gen. Sir Stephen Chapman.
Admiral Sir Edward Codrington.
Thomas Stephens Davies, Esq.
General Lord de Blaquiere.
Thomas Galloway, Esq.
General Sir James Gordon, Bart.
John Greathed Harris, Esq.
John Kidd, M.D.
Charles König, Esq.
The Rt. Hon. Viscount Melville.
Major-Gen. Sir William Morison.
The Marquis of Northampton.
George Pemberton, Esq.
Richard Phillips, Esq.
Captain Daniel Ross.
Sir Francis Simpkinson.
Rev. John Pye Smith, D.D.
William West, Esq.
John Williams, Esq.

On the Foreign List.

C. C. J. Jacobi.	Jens Christian Oersted.
Henry Frederick Link.	Heinrich Christian Schumacher.

Defaulters.

E. H. Baily, Esq., R.A.	E. R. Daniell, Esq.

Withdrawn.

Sir Howard Elphinstone, Bart.	Thomas Jones.
Rev. F. W. Hope.	

Election Void.

John Russell Hind, Esq.

List of Fellows elected into the Royal Society since the last Anniversary (1850).

On the Home List.

His Grace the Duke of Argyll.	John Russell Hind, Esq.
Charles Cardale Babington, Esq.	Augustus William Hofmann, Esq.
Thomas Snow Beck, M.D.	Thomas Henry Huxley.
Charles James Fox Bunbury, Esq.	William Edmund Logan, Esq.
George T. Doo, Esq.	James Paget, Esq.
Edward B. Eastwick, Esq.	George Gabriel Stokes, Esq.
Captain Charles M. Elliot.	William Thomson, Esq.
Captain Robert FitzRoy, R.N.	Augustus V. Waller, M.D.

The President then addressed the Meeting as follows:—

Gentlemen,

The year that is passed, though not remarkable for any very startling discovery, has contributed a full average to the advance of human knowledge: in all directions there has been steady progress, new facts springing up in rapid succession, the fruits of inquiries carried on with perhaps more energy, with more system, and upon a greater scale than at any previous epoch in the history of science. Our continental neighbours, happily exempt from internal troubles, have been free to pursue their scientific labours; and our brethren in America, with that energy which is daily winning for them such signal triumphs in the arts of peace and civilization, though later in the field, yet fresh and full of hope, have taken a distinguished place.

I need hardly remind you that at home the indications of active progress are no less striking. Here we have had an unusual number of papers, and the size of the last volume of the Transactions is evidence that a large proportion were of sterling worth. Many also have expressed their readiness to undertake new researches on re-

ceiving a certain amount of assistance from the Government Grant; and although no one has proposed any very extensive series of experiments, still many facts no doubt will be obtained in various departments of science,—a valuable addition to human knowledge; but, scattered over science at large, they will not of course make that brilliant display which they would do if concentrated, as in M. Regnault's inquiry, on one specific object.

I may also add, that many distinguished men have recently come forward here as candidates, and I am happy to say that so far the new Statute appears to be working very well, and as yet I do not see any probability that men of unquestioned merit will have too long to wait for admission.

Your Council having awarded the Copley Medal to Professor Owen, it becomes my duty to give some account of his discoveries. They cannot be described by a mere reference to one or two great works: they have appeared successively in a variety of publications, and are so numerous, that to notice each, however slightly, will almost take up more time than I can venture to ask for. Any further general observations would therefore be inadmissible; and thanking you and the Council for the kind assistance I have received during the past year, and indeed on all occasions, I will at once proceed to state the grounds of the award of the Copley Medal.

The Contributions to Comparative Anatomy and Physiology, made by Professor Owen in published works, began to appear about the time of the decease of Cuvier in 1832, and have been continued with brief interruptions since that period to the present time: the mantle of that great man seems to have descended, at his death, upon the shoulders of our distinguished countryman; and it is not a little interesting to remark how this circumstance has produced, as it were, an uninterrupted succession of important discoveries in these and the collateral sciences, during a period, already passed, of sixty years, by two men of different countries indeed, but the character of whose minds, and the originality and importance of whose discoveries and generalizations, have placed them on an eminence, not reached by any other philosophers of modern times, in the same branches of knowledge.

Professor Owen's earlier works are principally devoted to making known the labours of John Hunter, and facilitating, by the construction of an elaborate catalogue, the study of his unrivalled collection of anatomical preparations in the Museum of the Royal College of Surgeons.

It is unnecessary for me to do more than allude to the masterly manner in which this arduous task was performed. In 1840, the ten years' labour was completed by the publication of the fifth and last volume of a catalogue, which, for laborious research, for new and important views in anatomical and physiological science, is unrivalled in any age or country; and the Council of the College, in the advertisement to the last volume of the Physiological Catalogue, express "their great gratification in acknowledging the unremitting labour bestowed on the work by Professor Owen, to whom its pub-

lication has been exclusively confided." From the date of the publication of this catalogue, including as it does not only the description of 3790 Hunterian dissections, but also seventy-eight engravings of minute and elaborate drawings, together with the general observations left by Hunter, the true position of this great man in natural science became manifest, and a more just and ample recognition of his merits was produced, particularly on the continent.

These however were not the only labours of Professor Owen in connexion with his official duties. In addition to some minor catalogues and other works, I must not omit to mention the two well-known monographs, the 'Memoir of the Pearly Nautilus,' published under the auspices of the College in 1832; and that on the skeleton of a gigantic extinct Sloth (*Mylodon robustus*), published ten years afterwards.

The merits of these publications are fully recognised, and have received the highest praise from continental anatomists; and it is remarkable that the doubts which were expressed and long entertained, as to the accuracy of Professor Owen's restoration of the animal of the Pearly Nautilus to its shell, were completely dissipated by the first complete example obtained by the eminent Professor of the Garden of Plants, M. Valenciennes.

Our time will only allow me to take a slight glance at the learned and elaborate modification of the classification of the *Cephalopoda*, the reference of the spirula and the curious fossil Belemnite to the higher or dibranchiate order of this class of animals. For his memoir on certain of this family, with their soft parts fossilized, which was published in the Philosophical Transactions for 1844, the Royal Medal was awarded. This class of animals has been still further elucidated in Professor Owen's papers in the Zoological Society's Transactions, and in an elaborate article in the first volume of the Cyclopædia of Anatomy and Physiology.

The first communication received by the Royal Society from Professor Owen was on the Mammary Glands of the *Ornithorhynchus paradoxus* in 1832. These organs had been originally described by Sir Everard Home as masses of fat; they were afterwards recognised by Meckel as mammary glands in 1824: but their true nature was again disputed by Geoffroy St. Hilaire, who considered them as scent glands.

Professor Owen determined the question by observing the phases of change relatively between the ovaries and the glands in question, and established their true mammary nature, by the dissection in 1831 of no less than five female Ornithorhynchi and one Echidna; a doctrine, which was afterwards confirmed by observations made in Australia on the secretion itself of the gland.

In 1834 there appeared in the Philosophical Transactions Professor Owen's paper, describing impregnated specimens of Ornithorhynchus. In this paper he shows, by the structure of the ovisac, of the corpus luteum, and of the uterine ovum, that the latter must be developed *in utero*, and the young be born alive. He infers, from the structure of the chorion, that no placenta will be developed. The

problem still remained, how a quadruped, with a beak like a duck, could suck, or in any way obtain milk from a mammary organ without a nipple. In 1834 Professor Owen received specimens of young, and apparently newly-born, *Ornithorhynchi*, from Mr. George Bennett and Dr. Weatherhead; their form and anatomy are minutely described in a paper in the Transactions of the Zoological Society. The oral orifice was there shown to be exactly adapted to be applied to the areola of the breast on which the lactiferous ducts terminate, and to receive the milk that is injected into the mouth by a muscle that surrounds the large mammary gland*. The remains of fœtal peculiarities in these young specimens confirmed the inference from the structure of the ovum that the Ornithorhynchus was viviparous, but implacental.

Professor Owen's next step was to settle the questions undecided on the generation of marsupial animals—the period of uterine gestation, the exact condition of the new-born young, the mode of its passage to the external pouch, and the term of its suspension to the pendulous nipple. On all these points science was, as yet, uninformed. The Kangaroo (*Macropus major*) had bred in captivity, in both France and England. Professor Owen took advantage of the opportunities which the menagerie of the Zoological Society afforded to obtain exact data on the chief points which most needed elucidation. You will find the account of his experiments in the paper 'On the Generation of the Marsupial Animals,' in the Transactions of the Royal Society for 1834. The period of uterine gestation of the Great Kangaroo is shown to be thirty-eight days; the new-born animal is but one inch in length, naked, blind, with hind-legs and tail shorter than the fore-legs. He ascertained that the mother transferred her minute and delicate progeny from the vulva, to the nipple concealed in the pouch, by means of her lips; that the embryo instinctively adheres to the nipple, and is suspended to it for a period of six months.

In the Philosophical Transactions for 1837 appeared a memoir from Professor Owen's pen, describing certain peculiarities in the brain of the Marsupialia, especially the absence of the corpus callosum. The same condition he subsequently discovered in the Ornithorhynchus and Echidna. This and other peculiarities of structure in the sanguiferous, osseous and dental systems, led Professor Owen to suggest a modification of the classification of the Mammalia, which Cuvier had adopted in his last edition of the 'Règne Animal.' Deeming modifications of brain of more importance than those of the ungual phalanges, and connecting the higher development of the commissural system of the brain with the longer sojourn of the fœtus in the womb and its more intimate union therewith, Professor Owen, in his paper 'On the Classification of the Marsupialia,' in the Transactions of the Zoological Society for 1839, groups together all the Mammalia which have a placenta under any form, and which have

* An analogous arrangement had been previously shown to exist in the Kangaroo, by the late Mr. John Morgan.

the corpus callosum, in a primary *subclass*, under the name of '*Placentalia*'; the rest form the *subclass* '*Implacentalia*,' and this includes the orders *Marsupialia* and *Monotrema*. For a further development of these views, and of the organization of the *Implacentalia*, I may refer to Professor Owen's admirable memoir 'On the Osteology of the Marsupialia' in the Transactions of the Zoological Society, and to the articles 'Monotremata' and 'Marsupialia' in the Cyclopædia of Anatomy and Physiology.

Professor Owen further displayed modifications of the Cuvierian system on anatomical grounds, in his paper on the *Dugong* in the Proceedings of the Zoological Society for 1838, in which he separated the *Herbivorous* from the true or *Carnivorous Cetacea*.

The anatomical and palæontological evidence for the association of the Ruminantia with other hoofed quadrupeds having the toes in equal number, in one natural order, called *Artiodactyla*, and for the grouping together of other hoofed animals with the toes in unequal number, in a second order called *Perissodactyla*, is given in the Quarterly Journal of the Geological Society for November 1847.

In regard to that family of Quadrumanous Mammalia which approach most nearly to Man, much obscurity prevailed at the close of Cuvier's labours. That great naturalist places the Orang-utan at the head of the order, from being acquainted with only the immature condition of the Chimpanzee. The knowledge of the osteological and dental characters of the *adults* of both forms, of their true facial angle and cerebral capacity, were first made known in Professor Owen's memoirs printed in the Zoological Society's Transactions; and here most of those characters which were supposed to approximate these animals most nearly to Man, are shown to be transitory, and peculiar to the young state of the animal with deciduous teeth.

In a second memoir in the second volume of the Zoological Transactions, Professor Owen gives the requisite details of the change of dentition, and describes a second species of Orang from Borneo (*Pithecus morio*). In a third memoir the cranial and dental characters of a second species of Chimpanzee (*Troglodytes gorilla*), of formidable strength and stature, discovered by Dr. Savage, are detailed in the third volume of the Zoological Transactions, to which Professor Owen has since added two memoirs descriptive of the entire skeleton of the *Troglodytes gorilla*, and the relative capacities of the cranium of the Orangs, Chimpanzees, and the different varieties of the human race.

With regard to the class of Birds, I may refer to Professor Owen's monograph on the Anatomy of the Toucan in Mr. Gould's works on the Rhamphastidæ; to his memoirs on the Anatomy of the Hornbill in the first volume of the Transactions of the Zoological Society; and to two elaborate monographs on the Anatomy of the *Apteryx Australis*, in the same Transactions.

The comparison of the organization of the latter remarkable species with that of the larger struthious birds, and, above all, the accessions to the same wingless order which we owe to Professor Owen's memoirs on the fossil remains of the *Dinornis* and *Palapteryx* obtained from the Islands of New Zealand, supplied him with the requisite grounds

for separating from the Grallæ of the Cuvierian system, the species that therein form the family '*Brevipennes*,' and in raising them to the rank of an order. This and other modifications of the Cuvierian classification of birds, and an inquiry into the grounds for a binary division of the class according to the condition of the newly-hatched young, *e. g.* into *Aves altrices* and *Aves præcoces*, will be found in Professor Owen's article *Aves* in the Cyclopædia of Anatomy and Physiology. Perhaps none of Professor Owen's researches on Fossil Remains have excited more general interest than those to which we are indebted for a knowledge of the gigantic Struthious Birds of New Zealand, the first paper on which is to be found in the third volume of the Transactions of the Zoological Society. I cannot avoid quoting on this subject the words of a distinguished geologist, a Fellow of the Society, in the 4th volume of the Quarterly Journal of the Geological Society.

"The first relic of this kind was made known to European naturalists by Professor Owen, in 1839. It consisted of the shaft of a femur or thigh-bone, but a few inches long, and with both its extremities wanting; and this fragment so much resembled in its general appearance the marrow-bone of an ox, as actually to have been regarded as such by more than one eminent naturalist of this metropolis. And if I were required to select from the numerous and important inductions of palæontology, the one which of all others presents the most striking and triumphant instance of the sagacious application of the principles of the correlation of organic structure enunciated by the illustrious Cuvier,—the one that may be regarded as the *experimentum crucis* of the Cuvierian philosophy,—I would unhesitatingly adduce the interpretation of this fragment of bone. I know not among all the marvels which palæontology has revealed to us, a more brilliant example of successful philosophical induction—the felicitous prediction of genius enlightened by profound scientific knowledge.

"The specimen was put into Professor Owen's hands for examination, and from this mere fragment, the Hunterian Professor arrived at the conclusion, 'that there existed, and perhaps still exists in those distant islands, a race of struthious birds of larger and more colossal stature than the Ostrich or any other known species.' This inference was based on the peculiar character of the cancellated structure of the bone, which differs from that of mammalia, and most closely resembles that of the Ostrich. And so confident was Professor Owen of the soundness of his inductions, that he boldly added, 'so far as my skill in interpreting an osseous fragment may be credited, I am willing to risk the reputation for it on this statement;' and he further remarks, 'The discovery of a relic of a large struthious bird in New Zealand is one of peculiar interest, on account of the remarkable character of the existing fauna of those islands, which still includes one of the most extraordinary and anomalous genera of the struthious order, the *Apteryx*; and because of the close analogy which the event indicated by the present relic offers to the extinction of the Dodo of the island of the Mauritius. So

far as a judgement can be formed of a single fragment, it seems probable that the colossal bird of New Zealand, if it prove to be extinct, presented proportions more nearly resembling those of the Dodo, than of any of the existing *Struthionidæ*.' In 1843 the correctness of these views was confirmed in every essential particular by a large collection of bones obtained by the Rev. W. Williams and transmitted to the Dean of Westminster; and still further corroborated by another interesting series brought to England in 1846 by Percy Earl, Esq."

It would be too long a trespass on your time to cite even the titles of the numerous Papers, Reports and Works in which the results of Professor Owen's researches in the field of Palæontology are recorded; and I am forced to pass with only an allusion, the numerous cases in which a fragment of a tooth has enabled him to decide the affinities of the animal to which it belonged, and to render the fragmentary remains of bones the means of determining the forms and relations of their former possessors. I may just enumerate as examples in illustration of the successful extent to which this principle of investigation was carried, its application to the Toxodon, the Mylodon, the Schidotherion, the Glyptodon, and many others.

This application of Comparative Anatomy to the right interpretation of the fragmentary remains of lost forms of animal life, is the last and perhaps the highest power which the cultivator of that science gains as such. It began now to be applied in a systematic manner by Professor Owen to the elucidation of the ancient zoology of this island. His first Report 'On British Fossil Reptiles,' was communicated to the British Association in 1839, the second and concluding Report on the same subject in 1842.

Subsequent researches on the extinct animals of the same class have been communicated in the Memoirs printed in the Transactions of the Geological Society, amongst which we may notice that on the Dicynodont Reptiles of South Africa; a Memoir on the Rhynchosaurus in the Transactions of the Cambridge Philosophical Society; and in Monographs contributed to the publications of the Palæontological Society. The matter of these Monographs and of the Reports has been methodized into a systematic 'History of British Fossil Reptiles,' now in course of publication, of which five Parts, each illustrated by twenty quarto or folio plates, have appeared.

In 1842 Professor Owen communicated his first Report 'On British Fossil Mammalia' to the British Association; and, in 1843, his second and concluding Report on the same class of extinct animals.

Both these and the preceding Reports on the Fossil Reptilia were drawn up at the instance of the British Association for the Advancement of Science, and the researches they necessitated were carried on chiefly by aid of grants from that body.

In the illustrated 'History of British Fossil Mammalia and Birds,' published in 1846, Professor Owen developes his generalization as to conformity of Geographical Distribution in the extinct and existing

forms of Mammalia, which he had progressively worked out in previous palæontological writings.

As examples of Anatomical Monographs, I may refer to the memoir on the *Lepidosiren annectens*, in the Linnæan Transactions for 1839; 'On the Anatomy of the Rhinoceros,' in the Zoological Transactions, and to the Papers 'On the Eustachian Canals in the Crocodile,' 'On the Carapace and Plastrum of the Chelonia,' 'On the Dentition of the Phacochœrus or Wart-Hog,' and 'On the Exogenous Processes of Vertebræ' in the Philosophical Transactions.

The value of microscopical research in comparative anatomy has been already alluded to, and a fresh instance of its importance is given in the elaborate researches on the subject of the Teeth, the first results of which were communicated in a report to the British Association at the Meeting at Newcastle in 1838, and they were ultimately embodied in the great work entitled 'Odontography,' comprising one volume of text and an atlas of 168 plates, in which the diversified modifications of the dental tissues in all classes possessing teeth are fully illustrated.

The minute structure of scales and other dermal appendages of Fishes has been studied microscopically by Professor Owen, who was led by the phenomena he observed to oppose the views of the development of scales by excretion, which M. Agassiz had contended for; and he demonstrates the close analogy which exists between the dermal bony tubercles and spines of the cartilaginous fishes and their teeth.

Professor Owen's views have been confirmed, the analogy extended, and a variety of beautiful modifications of tooth-like structure demonstrated by Dr. Williamson in his papers recently published in onr Transactions.

Of the application of the microscope by Professor Owen to the solution of some of the mysterious problems of generation, examples will be found in his 'Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals,' published in 1843; in those 'On the Generation and Development of Animals,' published in 1849–50; and in his work 'On Parthenogenesis, or the successive production of Procreating Individuals from a single Ovum,' also published in 1849. In the latter work Professor Owen shows the intent of the 'cleavage process,' as it has been called, to be that by which the spermatic principle is distributed throughout the germ-mass: and he there points out the consequent relation of such inherited subdivision of the spermatic principle to future developments of embryos in virgin parents. As propounded in this work, the theory became capable of application to many other cases besides that to which it was first applied.

The progress of Natural History has added many analogous instances of virgin-generation to that of the *Aphides*. In all these Professor Owen calls attention to the proposition of the primary cell-structure of the impregnated germ, which is retained in the procreative larvæ. Dr. Steenstrup has very ably and very ingeniously generalized the phenomena in question in his well-known essay on 'Alternation of Generations.'

The progress of all sciences is a perpetual struggle after generalizations of a higher and higher order. Anatomy and physiology, so actively cultivated in the time of Cuvier, had afforded at the latter end of his career, glimpses of generalizations, which, under the vague terms of "unity of organization," became subjects of sharp controversy. The idea, so expressed, had two applications,—*one*, to the analogies which exist between the permanent organization of the lower animals, and certain transitory states of the higher species; *the other*, to the correspondences traceable between the parts composing the organization of different species.

With reference to the first of these applications, I cannot do better than quote the author's own account of his conclusions, as given in the last lecture of his course on the Invertebrate Animals, published in 1843.

"The extent to which the resemblance, expressed by the term 'Unity of Organization,' may be traced between the higher and lower organized animals, bears an inverse ratio to their approximation to maturity. All animals resemble each other at the earliest period of their development, which commences with the manifestation of the assimilative and fissiparous properties of the polygastric animalcule: the potential germ of the mammal can be compared, in form and vital actions, with the Monad alone, and, at this period, unity of organization may be predicated of the two extremes of the Animal Kingdom. The germ of the Polype pushes the resemblance farther, and acquires the locomotive organs of the Monad—the superficial vibratile cilia—before it takes on its special radiated type. The Acalephe passes through both the Infusorial and Polype stages, and propagates by gemmation, as well as spontaneous fission, before it acquires its mature form and sexual organs. The fulness of the unity of organization which prevails through the Polypes and larval Acalephes, is diminished as the latter acquire maturity and assume their special form.

"There is only one animal form which is either permanently or transitorily represented throughout the Animal Kingdom,—it is that of the infusorial Monad.

"Other forms are represented less exclusively in the development of the Animal Kingdom, and may be regarded as secondary forms. These are, the Polype, the Worm, the Tunicary, and the Lamprey; they are secondary in relation to the Animal Kingdom at large, but are primary in respect of the primary divisions or sub-kingdoms.

"Thus the Radiata, after having passed through the Monad stage, enter that of the Polype: many there find their final development; others proceed to be metamorphosed into the Acalephe or the Echinoderm.

"All the *Articulata*, at an early stage of their development, assume the form or condition of the apodal and acephalous worm; some find their mature development at that stage, as the Entozoa; others proceed to acquire annulations; a head; rudimental feet; jointed feet, and finally, wings: radiating in various directions and degrees from the primary or fundamental form of their sub-kingdom.

"The *Mollusca* pass from the condition of the ciliated Monad to that of the shell-less Acephalan, and in like manner either remain to work out the perfections of that stage, or diverge to achieve the development of shells, of a head, of a ventral foot, or of cephalic arms.

"The vertebrated ovum having manifested its monadiform relations by the spontaneous fission, growth, and multiplication of the primordial nucleated cells, next assumes, by their metamorphosis and primary arrangement, the form and condition of the finless cartilaginous fish, from which fundamental form development radiates in as many and diversified directions and extents, and attains more extraordinary heights of complication and perfection than any of the lower secondary types appear to be susceptible of."

To the second application of the principle, I must more particularly refer, as the subject on which perhaps Professor Owen's investigations have been more fully and elaborately and systematically carried out, and have exercised a more important and universal influence on these sciences than any other,—I mean the doctrine of Homologies, or the correspondency of parts and of plan in the construction of animals. This had been the subject of close and sharp discussions in the Academy of Sciences between Cuvier and Geoffroy St. Hilaire, which are summed up by the latter in the 'Principes de Philosophie Zoologique,' published in 1830; and it can be no matter of surprise, that with an antagonist so strong in his well-founded reputation, as a great master in science, and so skilful in applying the weapons of a severe and sarcastic logic, Geoffroy St. Hilaire should have failed to impress the physiological world with those views which Cuvier objected to, as being based upon *à priori* speculation.

The effect of these discussions may be traced in most of the ablest works on Anatomy and Physiology which subsequently appeared, as, *e. g.* those by Prof. John Müller, Prof. Wagner, Milne-Edwards, Siebold and Stannius; and in the 'Outline of the Animal Kingdom' and 'Manual of Comparative Anatomy' by Professor Jones of King's College, London. By all these authors, the principle of Unity of Organization, as it has been attempted to be illustrated and applied by Geoffroy St. Hilaire, and by the German Anatomists of the Trancendental School of Schelling, is tacitly or avowedly abandoned. By M. Agassiz it was directly opposed.

Nevertheless, the question whether the principle of a common pattern, or the principle of final causes, or, as Cuvier called it, 'conditions of existence,'—I say, which of these two principles, or in what degree both have governed the development of organization of animals—the greatest question which can occupy the philosophical anatomist—was still far from having been satisfactorily decided.

It enforced itself upon the most serious consideration of Professor Owen, when he was called upon to prepare the Catalogue of the Osteological Collections in the Museum of the Royal College of Surgeons: and the results of this consideration were promulgated

in his Lectures on Comparative Osteology, given in the Theatre of the College.

What those results are, may now be studied in his 'Report on the Homological Relations of the Skeleton,' submitted to the British Association at Southampton in 1846, in his 'Lectures on the Vertebrate Animals,' 1846, and in his works entitled 'On the Archetype and Homologies of the Vertebrate Skeleton,' 1848, and 'On the Nature of Limbs,' in 1849.

It does not become me, if even time permitted, to enter upon an analysis of these works. I believe them to be well known to all my anatomical and physiological hearers, and that the doctrines they contain, new rather than revived—new at least, in the best sense, as being the results of strict induction,—have been generally received.

In the comprehensive 'Principles of Physiology, General and Comparative,' by Dr. Carpenter, the first systematic work on the subject which has appeared in our language since the promulgation of Professor Owen's views, that author adopts the philosophy of the skeleton therein set forth, borrows the illustrations of the Vertebrate Archetype, and characterizes the works from which he quotes as "examples of that rare combination of logical appreciation of facts, with originality in the conception of ideas, which distinguishes the true philosopher from the rash speculator on the one hand, and from the mere plodding observer on the other."

Sir Charles Lyell, in his last 'Anniversary Address' to the Geological Society, speaks of the same works as being "distinguished by grand and comprehensive views in regard to the relations of different parts of the vertebrate creation to each other."

Dr. Carus, in the attempt to follow out the homologies of the muscles on the principles laid down by Professor Owen, in his 'Lectures on the Vertebrate Animals' for the application of his philosophy to that system, acknowledges it as "indicating the only true way to the comprehension of a scientific myology."

The great aim of Professor Owen's works on Homological Anatomy, appears to be to put an end to the old controversy so long maintained, on the assumption that a special adaptation of parts was incompatible with a common type of construction. Having, after long pains-taking researches, arrived at a clear conception of the archetypal plan of the vertebrate structures, he associates that idea with as clear a recognition of the teleological signification of the great principle as our finite capacities are able to attain to. "For it is certain," writes Professor Owen, "that in instances where the analogy of a machine fails to explain the structure of an organ, such structure does not exist in vain, if its true comprehension lead rational and responsible beings to a better conception of their own origin and Creator." Thus, far from giving support to Transmutational or Pantheistic notions, the conclusions of the Homologist being based on a rigorous deduction from carefully observed facts, furnish new arguments in support of the highest truths.

Our allotted time has prevented me from entering, to any extent,

into many of the subjects which have been elucidated by the researches of Professor Owen. But I think the sketch which I have been able to lay before you, presents such an amount of labour, guided by genius, and rewarded by important results, as is scarcely exampled in the history of natural science, and shows how justly the Council have decided in awarding the highest honour the Royal Society can bestow, on Professor Owen.

The Royal Medal in the department of Astronomy having been awarded to the President, Colonel Sabine addressed his Lordship as follows:—

Lord Rosse,

It falls to me to present to your Lordship the Royal Medal in the department of Astronomy, merited by researches not more remarkable from the universal interest which they inspire, or the brilliant and unexpected results which crown them, than from the rare combination of industry, patience, inventive genius, and scientific power to which they owe their success. You have reopened a field of investigation which seemed almost exhausted by two of the most illustrious observers of this or any age; and have added another proof of the great truth, that wide as is the range of human intellect, the wonders of Divine Wisdom lengthen out without limit beyond that range on every side. Even in your first memoir 'On Nebulæ' (Philosophical Transactions, 1844), it was evident that the resolution of a large proportion of those mysterious forms into clusters might be expected, and that even with the optical power of a three-feet reflector their configurations would assume new aspects:—and these anticipations have been fully realized by the gigantic instrument whose first fruits you have presented to the Royal Society. Without attempting to analyse your second memoir, which must be familiar to all who think in this department of Astronomy, I would notice as most prominent:—

1. The resolution of a great number of Nebulæ not previously resolved; and the discovery, that in most of these the stars are neither uniform in magnitude nor distribution. In the most remarkable, the great Nebula of Orion, its components are very minute, but crowded in knots, giving it a mottled appearance; while in others (the Dumb bell for example), such small stars envelope an assemblage of others of greater magnitude. Thus, the tokens of resolvability, which the sagacity of Sir John Herschel had discerned, are verified, and their application warranted to such Nebulæ as resist even the six-foot reflector. There is no line of demarcation between Clusters and Nebulæ.

2. Nor have the symmetric forms and exact circular or elliptic outlines which many of the Nebulæ were supposed to possess, when seen with instruments too weak to bring out many of their details, any existence: the hypothesis which infers from such appearances their gradual consolidation under the influence of rotation and gravity

has therefore no foundation, and their actual arrangement rather indicates the operation of causes presenting a marked difference from those which act in our planetary system.

3. Your Lordship's researches have disclosed an arrangement even more astonishing and more suggestive than any which had been previously ascribed to Nebulæ;—that spiral conformation which prevails in so many instances, occasionally displayed with all the graceful precision of a geometric curve, but most frequently seen obliquely, and causing the appearance of curved luminous or dark bands. It is found connected with single or multiple centres, clusters or stars; with rings probably of stars, and even may be traced in ordinary clusters. What are the conditions of which it is the result? If the Astronomer finds it hard to conceive the laws which can maintain the permanence of a uniform globular cluster, how much enhanced is the difficulty, when to the perturbing forces which exist in that simplest case are added others, such as the vortex-like character of these marvellous forms!

All this would be much had it been achieved by one who sought the means of fathoming the depths of the sky in the workshops of Munich, Paris, or London; but it is much more when he not merely uses, but has himself created that transcendent explorer, whose possible existence would a few years since have been regarded with incredulity. You, my Lord, have not only overcome the difficulties which had deterred professional opticians, by a course of costly experiments continued with consummate skill and science for many years, but have made it a special object to communicate the knowledge so laboriously obtained for the public use. The Council has awarded to your Lordship the Medal which Her Majesty, our Patroness, has graciously placed at the disposal of the Royal Society, as the highest testimonial which, as your Lordship is one of the Council, it is in their power to offer; but we are sure that you would deem it even a higher one, should we be able to establish in another region an observer, who would imitate the course of discovery on which you have so gloriously entered; and which it is the earnest desire of every friend of science that you may long be permitted to pursue.

The President then addressed Mr. Newport.

Mr. Newport,

I am most happy that the important services you have rendered to Physiological Science have been again rewarded, and that the pleasing duty has devolved upon me of placing in your hands, a Royal Medal, for your paper 'On the Impregnation of the Ovum in the Amphibia,' First Series, published in the Philosophical Transactions for 1851.

In dealing with that obscure and difficult subject, you have proceeded cautiously, and in a true philosophic spirit, deriving your information from experiments, ingeniously contrived, and ably exe-

cuted. To have obtained some new and valuable results in such an inquiry, was certainly an important achievement; the value, however, has been enhanced by your deductions, which are cautious and wary, as well as interesting and new. Allow me to express a hope that your success may be a stimulus to farther efforts, to be rewarded by discoveries honourable to you, to this Society, and to English Science.

The President then called upon Mr. Christie to read the biographical notices of some of the deceased Members, which he handed to him.

By the death of Henry Christian Schumacher, on the 28th of last December, at the age of 70 years, the Society has lost a valuable and amiable associate; one who became the personal friend of all the scientific men with whom he had anything to do. He was born in Holstein in 1780, of highly respectable parents; but losing his father early, he was placed under the care of the Pastor Dörfer, until his mother removed to Altona for the sake of educating her two sons. The Gymnasium to which he was now sent was fortunately presided over by Jacob Struve, father of the zealous Pulkova astronomer, who earnestly instructed his promising pupil both in classics and mathematics; but being of a delicate constitution, young Schumacher sought sedentary amusements, and was indulged in his partiality for mechanics, which he specially applied himself to in order to satisfy his mind on the action of various instruments connected with astronomy. Having gained the highest honours of the Gymnasium, he now thought of studying the law, for which purpose he repaired to Kiel; but in 1804, being recommended as tutor to a noble family residing near Dorpat, his passion for mathematics returned under the encouragement of Professor Pfaff, of the University of that city, whom he assisted during the short duration of a work called the 'Astronomische Beyträge.' In 1807, he took his Doctor's Degree, and returned to Altona, two years after which he obtained the Danish Government's permission to complete his studies at Göttingen under the celebrated Gaüss, whose friendship he enjoyed to his death. But the year following he was appointed Professor of Astronomy at Copenhagen; and in 1813, he had the satisfaction of having an Observatory placed under his direction at Mannheim. In a couple of years more, however, he was promoted to that of Copenhagen, to fill the vacancy occasioned by the death of Professor Bugge.

Schumacher's active intelligence now led him to look around, in order to ascertain what was transacting in other countries;—and he accordingly obtained permission to visit France and England in 1819, with his intimate friend Repsold of Hamburg, the eminent mechanician; and benefiting by our great trigonometrical survey, even to obtaining the loan of Ramsden's Zenith-sector from the English Government, he commenced measuring the Danish arc of the meridian, from Lauenburg in Holstein northwards. This service requi-

ring his frequent absence from Copenhagen, he was allowed to establish himself at Altona, and there build an Observatory and Museum of astronomical and geodesical instruments of all countries. Although immersed in these duties, as well as in making various chronometric journeys for the express purpose of differentiating and fixing longitudes, he steadily kept an eye on the scientific operations of the rest of Europe; and he visited at successive times his correspondents at Paris, Munich, Berlin, Vienna and Pulkova; besides a frequent trip to Bremen to consult the truly philosophical Dr. Olbers, and an annual journey to Copenhagen to report progress to his warm patron Frederick VI., and the equally friendly Christian VIII.

At the age of 32, Schumacher married with judgement a lady of good family, Christine Madelaine Schoon, who survives him; and their family consists of three daughters and two sons, one of whom, Richard, has already distinguished himself in astronomy.

Professor Schumacher was polished in his manners, cheerful in conversation, and could speak in German, Danish, Russian, French, English and Italian. He was fond of drawing, a great adept in the game of chess, remarkably punctual in all his occupations, unwearied in his application to business, neat in his computations, and orderly with his instruments and books; while a refined mind pervaded all his actions. The benefits consequent on these habits spread wonderfully over his long succession of assistants, to whom his time and advice were never denied, and of whom no fewer than sixteen now hold ostensible scientific posts. During the late political struggle, the principal scientific societies of Europe entreated the Danish Government to continue the Altona Observatory, as an establishment of paramount value to the world; and so it appears to have been viewed by the contending parties, for they both offered him their support. He died, however, before that very lamentable war had ceased; and is succeeded by his worthy pupil Dr. Petersen. But it will be difficult to replace such a fulcrum of scientific intercourse as Schumacher proved to be; especially in establishing and continuing through twenty-seven years, that cosmopolitan bond of intellectual union the 'Astronomische Nachrichten,' of which, from his practical and theoretical knowledge, and his philological attainments, he was perhaps the most effective editor which Europe could have produced. Besides this he published 'Géometrie der Stelling von Carnot,' 'Sammlung von Hülfstafeln,' 'Astronomische Hülfstafeln,' 'Astronomische Abhandlungen,' and other works.

Schumacher had been elected into most of the Scientific Societies of the world, being thus honoured in America, Denmark, France, Germany, Great Britain, Italy, Russia, and Sweden; and his date of election as a Foreign Member of this Society is 1821. He also received decorations of knighthood from Prussia, Russia, Sweden, France and Belgium; on which last order being conferred on him, that of Leopold, for his connexion with the documents furnished by the Danish Government, he wrote to explain that the only participation he had with Major Olsen's surveys, was their resting on his triangulation. But his scrupulous delicacy was overcome when he was informed, in

reply, that it was rather the opportunity of honouring him that had been seized, for that the order had also been conferred on the Major. The latest favour he received from his own Sovereign, Christian the VIIIth, was the Grand Cross of the Order of Dannebrog, and Dannebrog's Man; which distinction was accompanied with a very complimentary letter, in which the monarch declared his esteem for literary and scientific merit.

When Lord Northampton's decease was announced in a literary journal (the Athenæum*), it was remarked, that "though it sounds like a truism to say that the union of science and station and exalted character in the same individual seldom fails to command esteem,"—this truism was precisely the tribute which suggested itself in this case. And it was no doubt true that esteem, produced by the kindness, courtesy, truthfulness, fairness, and good sense of his character, which qualities were made conspicuous by his rank, and his frequent appearance in public, was the universal sentiment entertained towards him; yet no one who knew him well could fail also to admire his fine intellect, richly cultured mind, and varied knowledge, both of literature, science and art. It was this union of qualities, rarely found in the same person, which especially recommended him to your choice for ten successive years as President, and endeared him to this Society, and to his extended circle of friends and acquaintances.

Spencer Joshua Alwyne Compton, Marquis and Earl of the County of Northampton, was born on the 2nd of January 1790. He was educated at Trinity College, Cambridge, and manifested a love for literature and the classics, which he cultivated with an assiduity not always found in men of his rank. He there not only laid the foundation of the accomplishments and information which distinguished him in after-life, but formed many friendships with eminent men, now ornaments of this Society; and these friendships were not only continued, but increased and strengthened during the remainder of his life.

On quitting the University, Lord Compton was returned to Parliament as Member for the town of Northampton. Spencer Percival, the Prime Minister of the day, was his near relative, and thus a political career of eminence was within his grasp. But a sense of duty led him to join the opposition ranks; and being defeated at the next Parliamentary election, he retired from the political field of the House of Commons. Lord Compton associated himself at this period with Wilberforce, and the noble and excellent men who devoted themselves to the cause of Africa. The same associations connected him with Sir James Mackintosh as a criminal law reformer.

In 1815 he married Miss M'Cleod Clephane, daughter and heiress of General Clephane, a lady whose native and original genius had been matured by the most careful cultivation. She was at an early age a favourite of Walter Scott, who was delighted with her genius

* The biographical notice in the Athenæum which was thus prefaced has been freely used on the present occasion.

and her love of poetry. Among many and consummate accomplishments, her poetical talent was perhaps her most remarkable gift. Lord and Lady Compton travelled in Italy, and the houses which they successively occupied in that beautiful land were the centres of attraction for refined and intelligent travellers. Lord Compton also interfered actively and effectively on behalf of some of the unfortunate Italians who fell under the severe measures of authority both in Lombardy and at Naples. For years Italy was the favourite residence of this excellent English family, and for years they might be pointed out to foreigners with pride as representatives of the British Aristocracy. But the greatest of all domestic calamities was impending. In 1830 Lord and Lady Northampton, who had succeeded to the honours of the family in 1828, were residing at Rome, when by a most sudden and overwhelming calamity he found himself a widower. Lord Northampton removed his family to England at once, and at his noble seat of Castle Ashby he devoted himself to the education of his children, and the cultivation of literature and science.

In 1830 he joined this Society, and his connexion with it is undoubtedly one of the most remarkable features of his life. When the Duke of Sussex resigned the Presidency, the feeling was general that he was a fit person to succeed his Royal Highness. Though his scientific attainments might not be profound, he was an ardent lover of science, and testified his love by gathering around him all those who had distinguished themselves in its various departments. He was elected President in November 1838, and annually re-elected until November 1848. During his term of office, with few exceptions, he was always in his place at the Meetings of the Council, and his attention to the business that came on, fairness, and good humour, were worthy of all praise.

The Soirées which he gave in his capacity of President were attended by all the rank and science in the country; and their influence upon the world generally was of the happiest nature. Perhaps we may regard the labours of men of science respecting magnetism, and especially the establishment of a connected system of magnetic observations over the greater part of the earth's surface, as one of the principal subjects which employed the Royal Society during his Presidentship; and the applications of Lord Northampton to the government on this subject were assiduously made and were always favourably received.

Lord Northampton had paid especial attention to geology and mineralogy. He was the discoverer of a new mineral in the lava of Vesuvius, which was after him named Comptonite. He communicated to the Geological Society a description of the Basaltic Rocks of the Isle of Mull, with which place, so remarkable both by its scenery and its geology, he was especially connected: and at a later period (in 1838) he made to the Geological Society another communication on Spirolites in Chalk and Chalk flints, the objects so distinguished being extremely minute organic fossils.

The British Association for the Advancement of Science was one

of the fields in which Lord Northampton's scientific zeal and knowledge, and the admirable qualities which enabled him to conciliate opposing views while he maintained the authority of rule and discipline, were seen to eminent advantage. He showed himself ready, upon multiplied occasions, and on the most sudden and unexpected emergencies, to give to that Association the benefit of his time, his talents, and his energy. This is not the occasion to enumerate his great services to that body, but the cause of the promotion of science which we have in common with that body, and the general sympathy prevailing between this Society and the Association, as shown by the number of our members who take a leading part in the Meetings of the Association, have made it allowable to say so much on a subject which Lord Northampton had very much at heart, and to which on several occasions he referred in his addresses.

Archæology was another of Lord Northampton's studies, to which he devoted much time. He was in the habit of travelling, both in England and in foreign countries, with the purpose of seeing, drawing, and annotating the most remarkable specimens of ancient, and especially of Gothic architecture. He accumulated in this way very considerable stores of drawings and notes, some of the results of which he circulated among his friends in various forms. These pursuits led him to take a lively interest in the Archæological Association, which was established on a plan similar to the British Association, and which afterwards separated into two bodies, to one of which, the Archæological Institute, he continued to render great services at its annual meetings.

Lord Northampton's acquaintance with literature was various and extensive, and some poems of his printed in a publication called the 'Tribute,' under circumstances which marked his considerate benevolence, are graceful evidences of his poetical feeling. His literary merits were recognised by his election to succeed Mr. Hallam as President of the Royal Society of Literature, which office he held at the time of his death. Lord Northampton was also a Trustee of the British Museum.

Besides the writings and publications which we have already noticed, he published at the time of the discussions respecting the Reform Bill, a pamphlet written in a tone of philosophical moderation and political wisdom, as probably even those would allow who did not agree with his views. The work was a letter addressed to Mr. Spring Rice, now Lord Monteagle, one of his oldest and nearest friends; and recommended a change in the law so that seats in the House of Commons should not be vacated by acceptance of office. The measure was however rejected by Parliament.

Lord Northampton's health was habitually delicate. For many years he had been afflicted by a spitting of blood; and on more than one occasion he had been obliged to retire from active life and England to repose in southern climates. His last tour abroad was made in company with his son-in-law, the late Viscount Alford, who was recommended to spend a winter in the east for the benefit of

his health. The change did not produce the hoped result. Lord Alford gradually sank; and his death proved too great a shock to the naturally sensitive temperament of Lord Northampton. He expired only a few days after the decease of his son-in-law, at his seat of Castle Ashby, on the 16th of January, surrounded by all the members of his family except a son, who was with his regiment in India.

It is difficult to abstain from dwelling longer on Lord Northampton's admirable gifts and accomplishments, and still more, on his virtues. He was full of kindness and benevolence for all who came under his notice, and seemed to be absolutely incapable of injustice or unfairness; and though a most clear-sighted judge of intellectual, scientific and artistical excellence, was with difficulty, if at all, moved to harshness towards shallow and petulant pretensions. He was zealous for the promotion of art as well as science in his native country; and even in the last days of his life his thoughts and his pen were engaged on a plan connected with that object.

Thomas Galloway, Esq., late a Member of the Council of this Society, died of disease of the heart on the 1st of November, at his residence in Torrington Square, and was buried at Kensal Green.

Mr. Galloway was born in the Upper Ward of Lanarkshire, on the 26th of February, 1796, his father being a farmer, and his grandfather a mechanical engineer. He was educated at the parish school of his neighbourhood, at the Academy of New Lanark, and the University of Edinburgh; at which last he entered in November 1812, and continued there eight sessions. At first he was mostly devoted to classical studies, but turned to mathematics as a special pursuit by the encouragement and teaching of the late Professor Wallace.

His first publication, probably, was the article on Pendulums in Brewster's Cyclopædia, about 1821; and he afterwards wrote various scientific articles in Leybourn's Repository and the Encyclopædia Britannica, and he moreover published a special work on 'Probabilities.' In the year 1823, he was elected Teacher in the Royal Military College at Sandhurst, where his accuracy of knowledge and business-like habits rendered him both efficient and popular.

In 1831, he married a daughter of his friend Professor Wallace; and in November 1832, he was selected for further consideration out of all the Candidates for the Chair of Natural Philosophy in the University of Edinburgh, by the Town Council, with Sir David Brewster and Professor Forbes; when the latter was elected. But in the year following he was called to undertake the important office of Register, that is, in modern language, Actuary of the Amicable Life Assurance Office, the oldest Institution of the kind; the duties of which he ably conducted to the day of his regretted death.

The gentlemen present will remember that Mr. Galloway was the author of an excellent paper on the 'Proper Motion of the

Solar System,' which was published in the Philosophical Transactions for 1847; and for which the Royal Medal was awarded to him. This interesting discussion was occasioned by Professor Argelander's having published an opinion on the probable situation in space towards which the sun is at present advancing. The inference thus drawn, was from an investigation of the proper motions of stars in the northern hemisphere; and Mr. Galloway was induced to inquire into the same question by a direct comparison of the positions of stars determined by Lacaille, with the recent Catalogues of Messrs. Johnson and Henderson, in the Southern hemisphere;—a considerable number of which appear to have very appreciable proper motions. This argument he entered into thoroughly, and with a neat and expressive mathematical computation; but he concluded, that the data were not yet sufficiently numerous to warrant any speculation with respect to the nature of the path which the sun describes in space.

Mr. Galloway was also the author of two valuable papers which were communicated to the Royal Astronomical Society, of which he was for some years a distinguished Secretary. The first of these, on the Application of the Method of Least Squares to the determination of the most probable errors of observation in a portion of the Ordnance Survey of England, was published in the Astronomical Memoirs for 1846: the second was on the present state of our knowledge relative to Shooting Stars, and on the determinations of differences of longitude from observations of those meteors,—a subject which he treated with his usual research and accuracy.

On the motion of Sir R. H. Inglis, Bart., seconded by Sir R. I. Murchison, the best thanks of the Society were tendered to the President for his excellent Address, and his Lordship was requested to permit the same to be printed and circulated among the Society.

The Statutes relating to the election of Officers and Council having been read, and Mr. G. R. Porter and Mr. S. P. Pratt having, with the consent of the Society, been nominated Scrutators, the votes of the Fellows present were collected.

The following Noblemen and Gentlemen were reported duly elected Officers and Council for the following year:—

President—The Earl of Rosse.

Treasurer—Lieut.-Colonel Sabine, R.A.

Secretaries—{ Samuel Hunter Christie, Esq.
Thomas Bell, Esq.

Foreign Secretary—Captain W. H. Smyth, R.N.

Other Members of the Council.—W. Bowman, Esq.; B. C. Brodie, Esq.; Professor Challis; Dr. W. Clark; Dr. Daubeny; Sir

Philip Egerton, Bart.; The Dean of Ely; J. P. Gassiot, Esq.; Dr. Marshall Hall; Sir John Herschel, Bart.; Professor W. H. Miller; Lieut.-Colonel Portlock, R. E.; Edward Solly, Esq.; W. Spence, Esq.; Dr. Wallich.

The thanks of the Society were given to the Scrutators for their trouble in examining the lists.

The following is a statement of the Receipts and Expenditure during the past year:—

Statement of the Receipts and Payments of the Royal Society between Nov. 30, 1850, and Dec. 1, 1851.

RECEIPTS.

	£	s.	d.
Balance in the hands of the Treasurer at the last Audit ..	156	18	8
Weekly Contributions, at one shilling	41	12	0
Quarterly Contributions at £4	1076	0	0
15 Admission Fees	150	0	0
5 Compositions for Annual Payments at £60	300	0	0
7 Compositions for Annual Payments at £40	280	0	0
One year's rent of estate at Mablethorpe: due at Michaelmas 1850 ..... 110 0 0			
One year's Income Tax 3 1 0			
	106	19	0
One year's rent of estate at Acton: due at Michaelmas 1851 ..... 70 0 0			
One year's Income Tax 2 0 10			
	67	19	2
One year's Fee farm rent of lands in Sussex: due at Michaelmas 1851	19	4	0
One year's rent from Royal College of Physicians	3	0	0
Dividends on Stock:—			
One year's dividend on £14,000 Reduced 3 per cent. Annuities 420 0 0			
Less Income Tax 12 5 0			
	407	15	0
One year's dividend on £6985 3*s.* 8*d.* 3 per cent. Consols 209 6 6			
Less Income Tax 5 17 8			
	203	8	10
Carried forward.....	2812	16	8

				£	s.	d.
Brought forward.....				2812	16	8
One year's dividend on £3452 1*s.* 1*d.*3 per cent. Consols, produce of sale of premises in Coleman Street.....	103	11	2			
Less Income Tax	3	0	4			
				100	10	10
Donation Fund.						
One year's dividend on £5331 10*s.* 8*d.* Consols	159	18	6			
Less Income Tax	4	13	0			
				155	5	6
Rumford Fund.						
One year's dividend on £2430 12*s.* 5*d.* Consols	72	17	9			
Less Income Tax	2	1	9			
				70	16	0
Fairchild Fund.						
One year's dividend on £100 New South Sea Annuities				3	0	0
Bakerian Lecture and Copley Medal Fund.						
One year's dividend on £366 16*s.* 1*d.* New South Sea Annuities	10	18	0			
Less Income Tax	0	6	2			
				10	11	10
Wintringham Fund.						
One year's dividend on £1200 Consols	36	0	0			
Less Income Tax	1	1	0			
				34	19	0
Miscellaneous Receipts:—						
Sale of Philosophical Transactions, Abstracts of Papers, and Catalogues of the Royal Society's Library				438	17	5
One-half Expense Printing Colonel Sabine's Magnetical Papers, Nos. 7, 8 and 9, repaid by Government.....				311	12	3
Total Receipts.....				£3938	9	6

PAYMENTS.

	£	s.	d.
Fairchild Lecture.—The Rev. J. J. Ellis, for delivering the Fairchild Lecture for 1851	3	0	0
Bakerian Lecture.—Professor Faraday, for the Bakerian Lecture for 1851	4	0	0
Carried forward.....	7	0	0

	£	s.	d.	£	s.	d.
Brought forward.....				7	0	0
Salaries:—						
S. H. Christie, Esq., one year, as Secretary..	105	0	0			
Thomas Bell, Esq., one year, as Secretary ..	105	0	0			
Ditto for Index to Phil. Trans.	5	5	0			
Capt. Smyth, one year, as Foreign Secretary..	20	0	0			
Charles R. Weld, Esq., one year, as Assistant-Secretary	300	0	0			
Mr. White, one year, as Clerk	100	0	0			
Porter	40	0	0			
				675	5	0
Purchase of £606 1*s.* 2*d.* 3 per cent. Consols				600	0	0
Fire Insurance, on the Society's Property				45	1	6
Gratuity to Bank Clerks				1	1	0
Ditto to late Porter's Widow				25	0	0
Powers, Cleaning Rooms and Books				13	11	0
Bills:—						
Taylor:						
Printing the Phil. Trans., 1850, part 2 ..	351	4	0			
Ditto, 1851, part 1.....	367	5	9			
Ditto, Proceedings, Nos. 76—81; Circulars, Lists of Fellows, Ballot-lists, Statement of Payments, Minutes of Council; Government Grant Committee, Notices, &c. &c.	162	9	8			
				880	19	5
Basire:						
Printing Plates in Transactions, 1850, part 2	174	19	0			
Engraving, 1851, part 1.....	26	19	0			
Ditto, part 2	71	6	6			
				273	4	6
Dinkel:						
For Lithography	34	14	0			
Wing:						
For ditto	70	19	6			
F. Gyde:						
For Wood Engraving.....	19	17	0			
				125	10	6
Bowles and Gardiner:						
Paper for the Phil. Trans., 1850, part 2,	158	8	0			
and 1851, part 1.....	143	11	0			
				301	19	0
Gyde:						
Boarding and Sewing 800 Parts of Phil. Trans., 1850, part 2	22	18	0			
Ditto, 1851, part 1.....	22	18	0			
Ditto, Extra binding	22	8	0			
				68	4	0
Carried forward.....				3016	15	11

				£	s.	d.
Brought forward.....				3016	15	11
Tuckett:						
Bookbinding	60	12	0			
Limbird:						
For Stationery	10	11	0			
Saunderson:						
For Shipping Expenses	21	7	6			
Brecknell and Turner:						
Candles, and Lamp Oil	41	6	0			
Arnold:						
For Coals	28	12	0			
Meredith:						
Mats, Brushes, Fire-wood, &c.	8	10	3			
Cubitt:						
For repairs and relaying Carpets, &c.....	26	18	0			
Slack:						
For Repairs	6	12	7			
Shoolbred:						
For Oil-cloth	4	7	0			
Charlton:						
For Cases and Shelves	20	7	3			
Sharpus:						
For China	3	5	3			
Humphries:						
For Livery	5	10	0			
Tea, Waiters, &c. at Ordinary Meetings	32	18	3			
Two Subscriptions over paid	8	0	0			
Draining Estate at Mablethorpe.....	54	11	0			
Visiting ditto	4	14	6			
				338	2	7
Books purchased:						
Dulau and Co.: for Books	18	19	6			
Taylor: for ditto	33	17	8			
Gould: for ditto	17	17	0			
Second-hand ditto	29	19	0			
				100	13	2
Taxes:						
Land and Assessed Taxes	9	1	1			
Income Tax	4	19	2			
				14	0	3
Copley Fund:						
Mr. Wyon, for Medals				37	17	0
Donation Fund:						
Mr. Ronalds	100	0	0			
Mr. Horner	50	0	0			
				150	0	0
Carried forward.....				3657	8	11

	£	s.	d.
Carried forward	3657	8	11
Few and Co.:			
Law Expenses	8	6	10
Petty Charges:			
Postage and Carriage	34 13 2		
Expenses on Foreign Packets, &c.	16 16 7		
Stamps	2 12 0		
Charwoman's Wages	27 6 0		
Extra Cleaning	2 2 0		
Miscellaneous expenses	41 15 6		
	125	5	3
Balance in the hands of the Treasurer	147	8	6
Total....	£3938	9	6

EDWARD SABINE, *Treasurer.*

December 1st, 1851.

Estates and Property of the Royal Society.

Estate at Mablethorpe, Lincolnshire (55 A. 2 R. 2 P.). Rent £110 per annum.

Estate at Acton, Middlesex (33 acres). Rent £70 per annum.

Fee farm rent in Sussex, £19 4*s.* per annum.

One-fifth of the clear rent of an estate at Lambeth Hill, from the College of Physicians, £3 per annum.

£14,000 Reduced 3 per cent. Annuities.

£20,005 9*s.* 11*d.* Consolidated Bank Annuities.

£366 16*s.* 1*d.* New South Sea Annuities.

The Receipts during the past year, exclusive of the Balance, amounted to:—£3781 10*s.* 10*d.*

The Expenditure during the same period, exclusive of the sum of £600 0*s.* 0*d.* invested in the Funds, was:—£3191 1 0

The Balance in hand, now belonging to the Donation Fund, is £120 16*s.* 11*d.*

Ditto, ditto Wintringham Fund, is £198 16*s.* 3*d.*

Annual Contributions.

1830	£363	4	0
1831	286	0	0
1832	255	6	0
1833	283	7	6
1834	318	18	6
1835	346	12	6
1836	495	0	0
1837	531	0	0
1838	599	4	0
1839	666	16	0
1840	767	4	0
1841	815	12	0
1842	910	8	0
1843	933	16	0
1844	1025	16	0
1845	1010	0	0
1846	1074	0	0
1847	1116	8	0
1848	1122	16	0
1849	1130	16	0
1850	1146	4	0
1851	1117	12	0

The following table shows the progress and present state of the Society with respect to the number of Fellows:—

	Patron and Honorary.	Foreign.	Having compounded.	Paying £2 12*s.* Annually.	Paying £4 Annually.	Total.
November 1850	12	50	441	17	278	798
Since elected	.....	.....	+9	.....	+6	+15
Since compounded	.....	.....	+5	.....	−5	....
Defaulters	.....	.....	.....	.....	−2	−2
Withdrawn	.....	.....	.....	.....	−3	−3
Since deceased	−1	−4	−18	−2	−6	−31
December 1, 1851	11	46	437	15	268	777

December 11, 1851.

COLONEL SABINE, R.A., V.P. & Treas., in the Chair.

The Chairman announced that the President had appointed the following gentlemen Vice-Presidents: Col. Sabine, R.A., the Rev. Prof. Challis, Charles Giles Bridle Daubeny, M.D., the Very Rev. the Dean of Ely, Sir John Fred. Wm. Herschel, Bart., and William Spence, Esq.

The reading of Dr. Faraday's paper, entitled "Experimental Researches in Electricity. Twenty-eighth Series. On Lines of Magnetic Force; their definite character; and their distribution within a Magnet and through Space," which was commenced on the 27th November, was resumed and concluded.

The author defines a line of magnetic force to be that described by a very small magnetic needle, when it is so moved, in either direction correspondent to its length, as to remain constantly a tangent to the line of motion; or as that along which if a transverse wire be moved in either direction, there is no tendency to the formation of an electric current in the wire, whilst if moved in any other direction there is such a tendency. Such lines are indicated by iron filings sprinkled about a magnet. These lines have a determinate direction; they have opposite qualities in and about this direction, and the forces in any part of them are determinate for a given magnet. They may, as the author thinks, be employed with great advantage to represent the magnetic force as to its nature, condition, direction, and comparative amount; and that in many cases when other representations of the force, as centres of action, will not apply.

The term *line of force*, as defined above, is restricted to mean no more than the condition of the force in a given place, as to *strength* and *direction*; and not to include any idea of the nature of the physical cause of the phenomena: at the same time if reason should arise to think that the physical condition of the force partakes generally of the nature of a current or of a ray, a view which the author inclines to, he sees no objection in the term, any more than to the terms *current* and *ray*, as they are used in considerations regarding electricity and light, because it may accord with such a view.

The *lines of magnetic force*, as defined above, may be recognized either by a magnetic needle or by a moving wire; but the two methods are founded on very different conditions and actions of the magnetic force, and the moving wire appears to have the largest application. Its principle can be applied in places which are inaccessible to the needle, and it can sum up the forces in a given plane or surface at any distance from the central magnet. It has no reference to results of attraction or repulsion, and in some cases is opposed to them; but the author thinks it gives a true view of the disposition of the magnetic powers, and leads, and will lead to a more correct understanding of the nature of the force. For these reasons he advocates its adoption, not to the exclusion of the needle,

but in conjunction with it; and proceeds to develope the experimental methods and their results, and first in the case of a bar magnet.

Two bar magnets, each 12 inches long, 1 inch in width, and 0·4 of an inch in thickness, were fixed, side by side, a little apart, with like ends in the same direction, on and parallel to an axis, so that they might act as one bar magnet and be revolved at pleasure about the common axial line. A wire, which entering at one pole was carried along the axis of the magnetic arrangement, was at the centre turned outwards at the equatorial part, and then made to return at a distance outside the magnet to the place from whence it commenced. At times this wire was in three parts; the axial part being one; a radial part extending from the centre to the surface at the equator and there connected with a copper ring surrounding the magnet, being another; and the part from this ring on the outside of the magnet, back to the place of commencement, being the third; and each of these could revolve either separately or in conjunction with the other parts, the electric contact being complete in all the cases, whilst the wire was insulated from the magnet by the covering of silk. The ends of this loop, as it may be called, were connected with a galvanometer, and thus the presence or absence of electric currents ascertained, and their amount measured. Two galvanometers were used; one by Ruhmkorff, containing fine wire, and very delicate in its action; the other, constructed by the author, of copper wire 0·2 of an inch thick, passing only once round each needle; this, for abundant currents of low intensity, such as those generated in the moving wire, was found many-fold more delicate in its indications than the former.

The general relations of a moving wire to the magnetic lines of force are then specified, and a reference is made to their discovery and description by the author in the First Series of these Experimental Researches; and the law of the evolution of the induced electrical current is given. Referring to an easy natural standard, it may be said, that if a person in these latitudes, where the lines of force dip 69 degrees, as shown by the dipping-needle, move forward with arms extended, then the direction of an electric current which would tend to be produced in a wire represented by the arms, would be from the right hand through the arms and body to the left.

It will be seen, upon a little consideration, that a wire which touches a regular bar magnet at one end, and is then continued through the air until it touches it again at the equator, if moved once round the magnet, slipping at the equator contact so as to resume its first position at the end of the revolution, will have intersected, *once, all* the lines of force external to the magnet, and neither more nor less, whatever its course through the air, or distance in parts from the magnet, may be. Now when the external part of the loop above described is moved in this manner a certain number of degrees round the axis of the magnet, the latter being still, a current of electricity in a given direction is shown by the galvanometer; and the proper precautions (which are described)

being taken, the current is of the same amount for the same number of degrees of revolution, whether the motion be quicker or slower, or whether the wire be at a greater or a less distance in its course from the magnet.

If the external part of the loop be retained fixed, as also the axial part, and the magnet with the short radial part of the wire be revolved, an electric current is again produced, of a strength exactly equal to the former for the same number of degrees of revolution; but its *direction* is the reverse of the first current, when the direction of revolution is the same. In either case, reversing the direction of the revolution reverses the current produced by it. The moving radial part of the wire is in this case insulated from the magnet, and many other experiments, as with discs at the ends of the magnet, show, that the motion of the magnet itself is indifferent; and that whether it revolve or is still, provided the wire move, the result is the same. When the radial wire or part of the loop, and the external part move together, then their effects exactly neutralize each other, as they ought to do, being in contrary directions, for the same revolution; and not the slightest trace of a current under the extremest conditions of motion, or of the experiment, can be perceived. Such is the case, whatever the course or distance of the external part of the loop may be, or even when the loop is altogether external to the magnet, but moving at the same angular velocity either with or around it.

When the axial part of the loop is revolved it produces no effect; neither if this part revolve or be still does it produce the least influence on any of the results already described; it acts simply as a conductor, and is in other respects perfectly indifferent. This axial wire may be replaced by the magnet itself; for when it exists only from the magnetic pole outwards, and when the radial wire has contact with the magnets at the centre, so as to complete the electric circuit, the results are exactly the same as before: or the axial wire may proceed to the centre and then make contact with the magnet, and the radial wire be removed; when precisely the same results occur: or both axial and radial parts may be removed, the magnet serving both for conductor and moving radius, and still the results are unchanged.

From such results as these, the author draws the following conclusions, in relation to the *lines of magnetic force* as defined at the commencement. The amount of magnetic force (as shown by the electric current evolved) is determinate; and *the same* for the same lines of force, whatever the distance of the point or plane on which their power is exerted is from the magnet: or it is the same in any two or more sections of the same lines of force. There is no loss or destructibility, or evanescence or latent state of the magnetic power. Convergence or divergence of the lines of force causes no difference in the amount of their power. Obliquity of intersection causes no difference. In an equal field of magnetic force the electricity evolved is proportionate to the time of motion, or to the velocity of motion, or to the amount of lines of force intersected.

The *internal state* of the magnet is then examined by means of the results obtained with the radial wire, or the moving magnet when the latter makes part of the circuit; and the conclusion is arrived at, that there are within the magnet lines of magnetic force as defined as, and exactly equal in amount to, those outside of it; that these are continuations of the former; and that every line of magnetic force, whatever distance it may extend to from a magnet, (and in principle that is infinite,) is a closed curve, which in some part of its course passes through the magnet in conformity with what is called its polarity.

A current being thus induced in a closed wire, when it travels across magnetic lines of force, an inquiry is next made into the effect of altering the *mass* or *diameter* of the wire, and another form of apparatus is employed, in which loops of wire are made to intersect a given amount of lines; each loop consisting of a given length of wire, but either of wires of different diameter, or of one or more wires of the same diameter. The conclusion arrived at is, that the current or amount of electricity evolved is not simply as the space occupied by the *breadth* of the wire correspondent to the direction of the line of force, which has relation to the polarity of the power; nor by that *width* or dimension of it which includes the number or amount of lines of force intersected, and which, corresponding to the direction of the motion, has relation to the equatorial condition of the lines; but is jointly as the two, or as the mass of the wire.

The moving wire was next surrounded by different media, as air, alcohol, water, oil of turpentine, &c., but the result was the same in all.

Wires of different metals were used, and results in accordance with those obtained and described in the Second Series of these Researches were obtained: the conclusion is, that the current excited appears to be directly as the conducting power of the substance employed. It has no particular reference to the magnetic character of the body; for iron comes between tin and platinum, presenting no other distinction than that due to conducting power, and differing far less from these metals than they do from metals not magnetic.

Magnetic *polarity* then comes under consideration. The author understands by this phrase, the opposite and antithetical actions which are manifest at the opposite ends, or the opposite sides, of a limited portion of a line of force. He is of opinion that these qualities, or conditions, are not shown with certainty in every case, by attractions and repulsions; thus a solution of sulphate of iron will be attracted by a magnetic pole if surrounded by a solution weaker than itself, as shown in former researches on diamagnetic and paramagnetic action; but if surrounded by a solution stronger than itself it will be repelled. Yet the direction of the lines of force passing through it and the surrounding media cannot be reversed in these two cases, and therefore the polarity remains the same. The moving wire however shows, in similar cases, the true polarity or direction of the forces; and for an application of its principles, in this respect, to the metals, an apparatus is described by which discs of different metals can be revolved between the poles of a horse-shoe

magnet and the electric currents evolved in them carried off to the galvanometer. Now, whether the discs be of paramagnetic or diamagnetic metals, whether of iron, or bismuth, or copper, or tin, or lead, the direction of the current produced shows, that the lines of magnetic force passing through the metals is the *same* in all the cases, and hence the polarity within them the same.

The author then gives a more explicit meaning, in accordance with the definition of *line of magnetic force* contained in this paper, to some of the expressions used in the three last series of his Researches on Magnetic Condition, Atmospheric Magnetism, &c.: and by referring to former results obtained since the year 1830, illustrates how much the idea of lines of force has influenced the course of his investigations, and the results obtained at different times, and the extent to which he has been indebted to it; and then, recommending for many special reasons the mode of examining magnetic forces by the aid of a moving conductor, he brings for the present his subject to a conclusion.

December 18, 1851.

WILLIAM SPENCE, Esq., V.P., in the Chair.

The following papers were read:—

"A Proof (by means of a series) that every Number is composed of 4 Square Numbers, or less, without reference to the properties of Prime Numbers." By Sir Frederick Pollock, Lord Chief Baron, F.R.S. &c. Received December 18.

The paper contains a proof, that if every number of the form $8n+4$ is composed of 4 odd squares, then every number whatever must be composed of 4 square numbers or less; also a proof of the converse of this, viz. that if every number is composed of 4 square numbers or less, then every number of the form $8n+4$ must be composed of 4 odd squares.

It is then proposed to show that every number of the form $8n+4$ is composed of 4 odd squares, by taking a number of the form $8n+4$, viz. an odd square $+3$, and showing that $8n+4$ in that case is divisible into 4 odd squares (other than the odd square and 1, 1, 1); thus $16n^2 \pm 8n+1$ is a form that includes every odd square, and $16n^2 \pm 8n+4$ is divisible into

$$4n^2 \pm 4n+1,$$
$$4n^2 \pm 4n+1,$$
$$4n^2 \pm 4n+1,$$
$$4n^2 \mp 4n+1.$$

8 is then added, and the sum is shown to be still divisible into 4 odd squares; and again 8, and so on, until by successive additions of $8+8+8$, &c., the quantity added to $16n^2 \pm 8n$ becomes equal to the original term with which the operation commenced. The odd squares $+3$ form the series 4, 12, 28, 52, 84, &c.; and if the suc-